

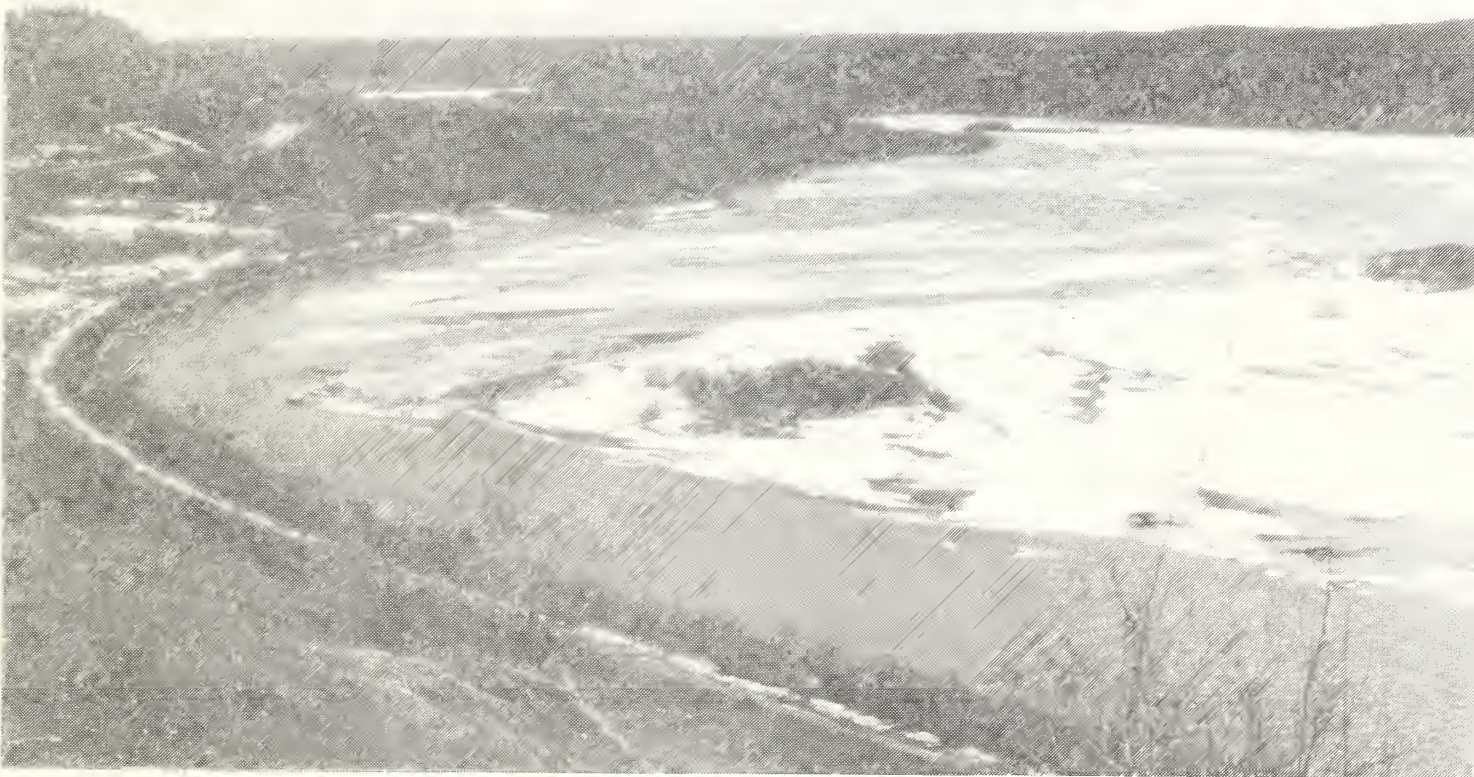
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# FLOOD PLAIN MANAGEMENT STUDY **COPPER RIVER COMMUNITIES**



prepared by

U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

JULY 1991

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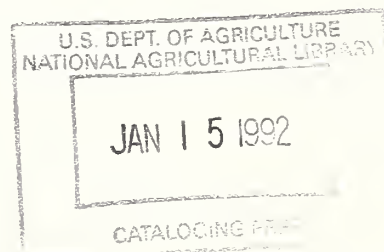
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# **FLOOD PLAIN MANAGEMENT STUDY**

*(Limited Intensity)*

## **COPPER RIVER COMMUNITIES**

Includes Gakona, Gulkana, Copperville Subdivision,  
Tazlina, Silver Springs Subdivision, Copper Center,  
Tonsina, and Lower Tonsina





## FOREWORD

The flood and erosion hazard information in this report will provide the State of Alaska, local planning groups, and residents of the study area with a basis for: formulating flood plain land use and management programs, informing the public of flood hazards, citing new facilities, classifying lands, and disposing of state lands. Options for minimizing flood damages in developed areas will also be discussed. Communities included in the study area are: Gakona, Gulkana, Copperville Subdivision, Tazlina, Silver Springs Subdivision, Copper Center, Tonsina, and Lower Tonsina.

As defined by Soil Conservation Service (SCS) policy, the study is of "limited intensity." The study was done as part of the Copper River Communities Cooperative Management Plan, a federal-state comprehensive planning process.

The Soil Conservation Service funded the study with appropriations from their River Basin Investigations and Surveys program. SCS also implemented the technical phases of the study and did most of the report preparation. The Kenny Lake Soil and Water Conservation District (SWCD) and the Alaska SWCD provided local contacts and information and reviewed and commented on report drafts. The Alaska Department of Natural Resources was helpful in reviewing and commenting on report drafts.

The cooperation of other federal and state agencies and property owners in the collection of data for this report is appreciated.



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# INTRODUCTION

## Local Study Needs

The communities involved in the study represent the main population centers of the area, and all have experienced past flooding and/or may be subject to future damage by flooding or erosional effects. While there are other locations within the upper Copper River Basin that have also experienced flooding problems, they are not included in the study because of low population density and property value.

This report projects approximate boundaries of flooding events, discusses present flood potential, and recommends programs for reduction of flood hazard. In these ways, the public and local planning boards can be informed of possible flood hazard areas for citing new facilities or retrofitting existing facilities and for developing land use management plans. Federal and state agencies can use this information for formulating flood plain land use and management programs and for classification and disposal of lands. Management programs implemented would reduce potential flood damage, assure wise land use, and maintain and enhance the riverine environment in the vicinity of the study communities.

## Study Authorities

The study is in accordance with the Copper River Communities' Cooperative Management Plan, an agreement between the Alaska Department of Community and Regional Affairs, Division of Planning; the Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys; and the U.S. Department of Agriculture, Soil Conservation Service. The agreement is authorized under Public Law 96-487.

Authority for SCS participation in flood plain management studies is provided by Section 6 of Public Law 83-566, the Watershed Protection and Flood Prevention Act and by Federal Level Recommendation 5(b) of *A Unified National Program for Flood Plain Management*, March 1986, Federal Emergency Management Agency. SCS carries out such studies in accordance with Executive Order 11988, 1977, *Flood Plain Management*. The authority for state cooperation in the study is stated in A.O.46 of Alaska State Laws.

To date there are no other flood related reports existing for the study area.

## DESCRIPTION OF STUDY AREA

### General

*Exhibit 1* is a location map of the study area, which includes selected communities in the central portion of the Copper River drainage basin above the confluence of the Chitina River. The Chitina River drainage, also part of the Copper River Basin, is not included in this report. Study communities include: Gakona, Gulkana, Copperville Subdivision, Tazlina, Silver Springs Subdivision, Copper Center, Tonsina and Lower Tonsina. Gakona is the northernmost study community and Lower Tonsina is the southernmost.

All of the study communities developed along transportation corridors during the gold rush days of the late 1890s, the Kennicott Copper mining period of 1907-1939, and during the post World War II highway construction period. Population density of the region is sparse, with approximately one person per four square miles. As of the early 1980s, total population was estimated to be 2,500 persons, while populations of the study communities ranged from about 40 persons at Lower Tonsina to about 250 persons at Copper Center. The population is composed of both native and non-native residents; in 1980 approximately 19 percent of the residents were native.

The study area falls outside of state-established boroughs. All of the study communities are unincorporated and have no form of local government. The local economy is based on fishing, mining, construction, Alaska Pipeline maintenance, highway maintenance, tourism, and employment with state and federal government agencies.

### Physiological Description

The study area is located in state hydrologic unit 190500003, in what may be described as the eastern part of south-central Alaska. The basin north of Chitina covers an area of about 21,000 square miles and is bordered by the Alaska Range to the north, the Wrangell Mountains to the east, and the Chugach Mountains to the west. Tributaries flow from these areas to the Copper River, which flows southward to the Gulf of Alaska.

Elevations within the study area range from 16,208 feet at the summit of Mt. Sanford to about 450 feet near Chitina. Topography can be divided into three regions; lowlands, uplands, and foothills and mountains. Copper River lowlands generally range from 1,000 to 3,000 feet in elevation. The Copper, Gulkana, Klutina and other study area rivers are found in this region. The upland area refers to land 3,000 to 5,000 feet in elevation. Above 5,000 feet foothills leading to the higher mountains begin. Much of the Copper River basin has experienced glaciation at some time, and today about 17 percent of the basin is covered by glaciers and perennial snowfields.

## Climate

The study area lies mainly within the continental climatic zone of Alaska. Variation in temperature is extreme, from -65°F to +90°F. Nearly 40 years of records at the Gulkana Airport show an average annual temperature of approximately 27°F. The time between freezing spring and fall temperatures for that period was on the average only 71 days.

Precipitation falling as rain and snow in lowland areas is less than 20 inches per year while mountainous areas receive from 40 to more than 80 inches per year. Nearly all precipitation that falls above 6,000 feet is snow.

Because of subfreezing average annual temperatures, perennially frozen ground or permafrost underlies most of the basin. Permafrost is not found below streams and lakes of the basin. In other areas of the lowlands, permafrost is usually within five feet of the surface.

## Soils

The soils of the study area and immediate vicinity are characterized by flood plains and stream terraces.

The flood plains are nearly level alluvial plains that border the active river channels and are subject to flooding during spring and summer run off and other episodes of high flow. Along the Copper River, two dominant flood plain levels separated by short, steep escarpments from one to three feet high are evident. The small elevational difference between these two levels result in significant variation in the frequency and duration of flooding over short distances.

Soils on the flood plains include the Klutina and Nizina soils. These soils are formed in stratified silty and sandy alluvium of varying thickness over very cobbly and gravelly substrata. In both Klutina and Nizina soils, organic matter content is relatively low, however, black sand grains impart a dark color to the surface. Lime coatings are common on gravel and cobble in the substrata of both soils.

Stream terraces are nearly level platforms separated by steep escarpments which border the river canyons immediately above the flood plains.

Stream terrace soils include the Gulkana and Kuslina soils. Gulkana soils are formed in a silty loess mantle over gravelly alluvium on upper terraces. The coarse textured substratum of Gulkana soils has a high volume of pore space, which enables rapid air exchange, warm soil temperatures and deep percolation of soil water. Compared to soils formed in similar materials on the flood plains, Gulkana soils are strongly developed with a bright colored subsoil. White calcium and magnesium carbonate coatings occur on the underside of coarse fragments in the substratum.

Kuslina soils, which occupy relic channel positions of the former flood plain, are formed in an admixture of silty loess and stratified silty and sandy alluvium. Kuslina soils have permafrost at a shallow depth and are poorly drained. Kuslina soils have a thick organic mat on the surface but are weakly developed otherwise.

## Vegetation

Vegetation on the lowest flood plain next to the active channel, which usually floods every year, consists of closed stands of alder and willow with an understory of horsetails and other herbs. This vegetation is well adapted to yearly flooding and quickly sends up new shoots through recently deposited alluvium. Higher flood plains, which receive significant overflow less often, support more diverse vegetation dominated by balsam poplar and white spruce. Alder, soapberry, horsetail, and a wide variety of herbs, lichens and mosses are found in the understory depending on stand age and degree of canopy closure.

Vegetation on Gulkana soils is dominated by white spruce, aspen, and mixed white spruce-aspen forests. Willow shrub occurs where there has been a recent burn.

Vegetation on Kuslina soils is dominantly white spruce and black spruce forest.

## Fish and Wildlife

The diversity of soils and landforms; variety of vegetation types; and system of lakes, streams, and wetlands of the Copper River area provide habitat for a wide variety of Alaska's game mammals, fish, and birds.

Rivers and streams in the Copper River drainage provide habitats for the migration, spawning, rearing and/or over-wintering of Chinook (King), Pink, Sockeye, Chum, and/or Coho salmon. Major subsistence fisheries are located in the Copper River and its tributaries. Copper River fish contribute substantially to commercial fisheries in the Gulf of Alaska. The Copper River and its tributaries, as well as local lakes, provide popular sport fishing spots for Rainbow trout, Arctic grayling, Dolly Varden and Burbot.

Moose, the most important big game animal in the survey area, are found throughout the Copper River Basin. They are common at higher elevations in summer and fall and concentrate along rivers at lower elevations in winter. Gakona and Christochina drainages, as well as the Alphabet Hills or Upper Gulkana drainage, support relatively high numbers of moose. Moose are seasonally abundant in other areas where high quality browse is available.

Two major caribou herds range within the Copper River area planning boundaries. The Nelchina caribou herd, which was estimated at 25,000 animals in 1984, occupies the upper Copper, Nelchina, and Susitna River Basins. The Mentasta caribou herd, which was estimated at 2,300 animals in 1984, occupies the northwest slopes of the Wrangell Mountains and the headwaters of the Copper River.

Dall sheep and mountain goats are found in the Wrangell and Chugach Mountains, and both black bears and grizzly bears are found in the Copper River area. Black bears utilize intensively the flood plains and stream terraces along the Copper, Klutina, and other major rivers. Grizzly bears occur throughout the uplands and concentrate along the Tonsina and other rivers and streams when salmon are running.

Among the more important fur bearers in the area are coyote, red fox, marten, lynx, muskrat, and beaver. Snowshoe hare and porcupine are common.

Approximately 135 species of birds are summer residents of the Copper River Basin area; another three dozen or so are spring-fall migrants or occasional visitors to the region. Lakes and wetlands interspersed throughout the basin provide important nesting and molting habitat for a wide variety of fowl including swans, bald eagles, and spruce grouse.

## FLOOD HISTORY AND MITIGATION

Flooding within the study area can be the result of several natural occurrences. This is typical of a landscape which is "young" in a geologic sense and where physical processes are very actively shaping the terrain. Flooding has been caused by the following or combinations thereof:

1) **ice jamming** - During the spring breakup period, ice flows may pile up or become trapped at bridges or river bends, forming an obstruction that backs up flow.

2) **debris clogging** - Similar to ice jamming but with the obstruction formed by trees carried by the river. This is unlikely to be the sole cause of major flooding and often occurs in conjunction with glacial lake breakouts.

3) **glacial outburst** - Typically occurs far upstream in the drainage basin when glacial water and snowmelt is trapped behind an ice jam in a glacial lake or by a glacier that has advanced rapidly and blocked off a watercourse. Eventually, enough water backs up behind the temporary dam that the dam breaks, sending a sudden surge of water down the length of the drainage basin.

4) **icing or "aufeis"** - Extremely cold temperatures acting upon moving water causes water to become super cooled and freezing progresses from the channel bottom upward. This eventually results in enough loss of channel capacity that overflowing occurs. Initial bottom ice is referred to as anchor ice.

5) **rainfall and meltoff** - This is a more typical cause of flooding in other parts of the country and the least likely cause of flooding in the study areas. Flooding occurs during periods of extreme rainfall and/or heavy runoff from glacial or snow melt.

6) **bank erosion** - Usually takes place over a longer period than the above, but can occur quickly

under heavy flooding. The occurrence of bank erosion mainly causes localized flooding.

Table 1 is compiled from available records and gives average discharge, maximum discharge (and corresponding gage height, if available), cause and date of flooding on rivers in the study areas. The following lists recorded flood events and describes mitigation measures.

## Gakona

Flooding is caused by ice jamming on the Gakona River at the Glenn Highway bridge. Erosion is occurring along the south bank of the river adjacent to the Gakona Lodge (registered historic site) and other buildings.

### Floods of record:

August 1956 - storm event (1)

March 1965 - ice jam (2)

May 1978 - ice jam - flooding reportedly lasted 19 days, was one foot deep between the highway and river and was alleviated by explosive work at the bridge (3)

Spring 1982 - ice jam - less severe than in 1978, flooded a cellar (3)

Mitigation. Around 1970 riprap was placed to protect the south bank of the Gakona River on the bend just upstream of the main cluster of buildings in Gakona. Ice jams at the highway bridge have been blasted to reduce flooding. The state has done extensive diking and riprap bank protection work along the north bank of the Copper River at the confluence and upstream and downstream of the Gakona River. Both banks of the Gakona have been protected where it enters the Copper River. The north bank of the Copper River has been protected for approximately 3500 feet downstream of this point to prevent the river from encroaching upon the high bank on which the highway runs. About one and a half miles upstream of the Gakona River bridge, the north bank of the Copper has been protected where the river pinches the Glenn Highway against a steep bluff. The south bank of the Gakona River runs along the opposite side of the Glenn Highway for approximately 4,000 feet upstream

of the bridge. The highway embankment acts as a dike for the Gakona at flood stage along this portion of the river.

## Gulkana

Information of past flooding is scarce for the village of Gulkana. The majority of homes in the village are in one cluster approximately 1,500 feet south of the Richardson Highway and elevated approximately 20 feet above the Gulkana River channel.

### Floods of record:

In 1986 - high water flooded the access road to the village

Mitigation. The low area between the old and new Richardson Highways east of the river has been vacated of structures. The old highway bridge was removed around 1975 with construction of the new bridge. No bank protection work exists within the area besides the riprap placed at the highway bridge abutments and 200-300 feet upstream.

## Copperville Subdivision

Flooding caused by ice jamming on the Copper River has occurred.

### Floods of record:

May 9, 1982 - ice jam - water rose quickly after the jam occurred flooding an estimated ten homes. Flooding reached a depth of three or four feet in at least one home, the Nagengast residence (4).

Mitigation. Residents of the community have requested that the state or federal government build a dike along the west bank of the Copper River to protect homes from flooding. No construction or other mitigation work has taken place to date.

## Tazlina

Debris deposition and bank erosion are caused by normal periods of high water, but of much greater significance, is flooding and erosion from glacial outburst far upstream in the ice fields above Tazlina Lake. Flood damage has been minimal. The Tazlina River is changing its channel approximately one mile

upstream from the bridge by cutting off a meander loop (neck cutoff), creating an oxbow lake, and increasing the potential for erosion on the right bank at the bridge. Glacial outburst flooding occurs on the average of once every two to three years (for the period of record 1952-1972).

Floods of record:

1926 - glacial outburst - took out the Richardson Highway bridge(4).

August 1962 - maximum outburst - when a flow of 60,700 cfs was recorded by a gage on the Richardson Highway bridge at Tazlina, a flow 3.3 times the average yearly maximum flow of 18,300 cfs(2).

1989 - summer - high water threatened the left abutment of the Tazlina River bridge (3)

Mitigation. Some riprap bank protection has been placed on the banks of the Tazlina near the highway bridge.

## Silver Springs Subdivision

To date no flooding has occurred though ice jam warnings have been issued several times in recent years.

## Copper Center

Flooding on the Klutina River at Copper Center has occurred a number of times but reportedly never from normal periods of high water from snow and glacial melt. Flooding is much more likely to be the result of icing (aufeis) of the Klutina River channel and subsequent overtopping of channel banks. Icing produced the most severe flooding the community has seen in December of 1964 with a maximum stage height recorded at 1,027.5 feet. Minor flooding, due to channel icing and/or excessive runoff at breakup in the spring, can occur on Yentna Creek, a tributary that crosses the Old Richardson Highway about one and a half miles north of the town center. Investigation of minor flooding during breakup, spring of 1989, concluded that a considerable portion of the runoff from the drainage area above the village of Copper Center collects at the culvert crossing for Yentna Creek at the Old Richardson Highway. Culverts are undersized and constrict flow thereby causing water to backup and flood properties upstream of the highway. The Copper River itself has not caused

flooding of Copper Center though erosion of the west bank of the Copper has occurred in recent times.

The Klutina River has the potential for high discharge due to glacial outburst events above Klutina Lake (the outlet of which is approximately 20 miles southwest of Copper Center). Glacial outburst has produced high flow at least twice in the period of record 1949-1970. No major flooding has occurred from these events. Peak discharge from the greatest outburst event of record in June of 1953 was 9040 cfs which represents a stage height reading of 1,020.5 feet or about 1.3 times the average yearly maximum flow of 6840 cfs (4). Therefore, while glacial outbursts may occur, such events are both less probable and less spectacular than outbursts on the Tazlina River.

Floods of record:

1935, 1945 and 1947 - icing on Klutina River - details are scarce, reportedly several homes were flooded.

1964 - icing on Klutina River - in mid-December persistent -50°F temperatures caused the icing and subsequent overflow of the Klutina at Copper Center. Twenty-eight structures in a 31-acre area adjacent to the river were jammed with ice and water to a depth of as great as six feet above ground (4).

1968 - bank erosion on the Copper River - during July severe erosion of the west bank just upstream of the main developed area of Copper Center brought the river approximately 200 feet closer to the community.

Mitigation. A dike or levee was built upstream of the Richardson Highway bridge by the Alaska Railroad Commission in the 1940s.

In October 1965, the Army Corps of Engineers excavated a narrow channel along the Klutina River from the highway bridge to the Copper River. Within a short time the channel was filled in with river deposited material.

On several occasions, including during the severe flooding of 1964, icing in the Klutina River channel have been opened up by use of explosives. Charges are set near the confluence with the Copper River and blasting proceeds upstream. Once a small channel is

opened, the cutting action of the flowing water continues to enlarge the flowpath.

In 1972 a major diking project was completed by the Army Corps of Engineers. The project was designed to protect against stages not exceeding a design flood of 1030.0 feet MSL measured at the Richardson Highway bridge. The dikes protect the main developed areas of Copper Center upstream and downstream of the Richardson Highway bridge on the north side of the river. Approximately 4,500 feet of dike averaging 10 to 15 feet in height was built.

In November 1985 the Army Corps of Engineers dredged a portion of the Klutina River channel at Copper Center to increase flow capacity.

## Tonsina

This community has experienced flooding in the past but, in recent years, has experienced only minor problems with flooding.

### Floods of record:

Flooding on the Tonsina River at Tonsina is recorded mainly during the late 1950s prior to improvements.

Minor flooding from Bernard Creek which runs northward to the east of the community has been a problem on several occasions. Bank erosion on the Tonsina and Little Tonsina Rivers upstream of the

community allows flow to move eastward toward the Richardson Highway. Squirrel Creek, which crosses the highway half a mile north of Tonsina, is not flood prone.

Mitigation. Bridge reconstruction and associated diking within the bridge area in 1974 (3) has prevented flooding from the Tonsina River at Tonsina in recent years. Spur or deflecting dikes with riprap armoring have been built in at least four places where the Little Tonsina and Tonsina rivers have cut and shifted next to the Richardson Highway.

## Lower Tonsina

Some stream overflow on the Tonsina River at Lower Tonsina reportedly occurred in 1957. Flooding has not been a problem in this area. Bank protection is in place to protect the Edgerton Highway bridge. There is sign of recent flooding, including sand deposits and debris, on the west bank of the Copper River north of the confluence of the Lower Tonsina River.

## References:

1. Author's estimation of cause based on date of occurrence when cause is undocumented
2. U.S. Geological Survey streamflow records
3. Personal interview
4. Army Corps of Engineers' records

# EXISTING FLOOD PLAIN MANAGEMENT AND PRESENT FLOOD POTENTIAL

## Existing Flood Plain Management

The Federal Emergency Management Agency (FEMA) through the State of Alaska Department of Community and Regional Affairs administers the National Flood Insurance Program. Through the program, federally subsidized flood insurance is available to owners and occupants of all buildings and mobile homes who follow set guidelines. A thorough description of the program is found in reference No. I of the Bibliography.

None of the study communities are eligible to formally participate in the program because they are unincorporated and presently have no program to control land use.

## Present Flood Potential

A flood plain is defined as any land area which is susceptible to flooding. Each of the study communities has permanent structures located in a flood plain area. Appendix A contains maps showing the extent of the predicted flood prone areas for each community. The 100 year flood plain, the area inundated by a 100 year flooding event or an event which has a one percent chance of occurring in any given year (as determined empirically from streamflow data records), is normally delineated in a flood plain study, however, due to the lack of actual streamflow record, in this study the flood boundary is a "flood prone" boundary predicted using historical records, on-site observations and soils classifications.

The following addresses the present flood potential of each study community.

### Gakona

Gakona has the greatest flood potential of all the communities studied. Most floods of record are spring floods caused by ice jams at the highway bridge though there is record of one high flow flood in August of 1956. There is considerable private property at risk in the immediate flood plain on the left bank upstream of the bridge including buildings of

historical significance. Continuous erosion along this stretch of bank is of concern though no mitigation has been accomplished. A site survey was made to determine the apparent extent of flooding and the boundary refined to coincide with the soil survey determinations where available.

### Gulkana

The Gulkana River has the lowest flood potential since all the community buildings are at an elevation 20+/- feet above the river channel. The Gulkana has been included in the this study for continuity. The flood prone boundary was determined by an on-site survey, using the design flood elevation used in construction of the present highway bridge, and was verified by the soils survey determinations.

### Copperville Subdivision

Ice jams on the Copper River at a constriction downstream of this subdivision cause flooding of those residences in the lowest lying areas. There is no flow data on this part of the Copper River or topographical survey data to predict high flow occurrences, and there is no historic record of high flow flooding; however, soils mapping in the area demonstrates flood prone soils to a much greater extent than otherwise predictable. Soil survey and site survey information were used to predict flood prone boundary.

### Copper Center

Flooding on the Klutina River at Copper Center has occurred a number of times but reportedly never from normal periods of high water from snow and glacial melt or rainfall. Flooding is more likely to be the result of aufeis and subsequent overtopping of channel banks. Since the construction of the Army Corps of Engineers dike along the north side of the river in 1972 protecting Copper Center, there has been no flood of record. The Copper River itself has not caused flooding of the Copper Center area though there is some threat of erosion of the west bank of the Copper River during high flows. Site survey and soils survey information were used to delineate the flood boundary.

## **Tazlina**

Glacial outburst flooding events cause most of the flooding damage and occur fairly predictably on a 2- 3-year cycle in the early fall. Since the cut-off of the meander loop upstream of the bridge, there is increased probability of erosion of the right bank downstream of the cutoff. Site survey and soils survey information were used to delineate the flood boundary.

## **Silver Springs Subdivision**

Though there is no record of flooding in the subdivision, one subdivision house on the bank of the Copper River is in the immediate flood plain and predictably can expect damage in the future. Flood prone boundaries were predicted using site survey and soil survey information. Geomorphic terraces are obvious in this area along the Copper, and the first terrace above the river channel was used to facilitate boundary determinations.

## **Tonsina**

Since a dike was installed in 1972, the immediate area around the Tonsina Lodge has not experienced further flooding; however, survey of the area using the design flood elevation used in construction of the highway bridge shows potential inundation of the dike and lodge buildings. The Tonsina Lodge and out-buildings appear to have been vacated. The Tonsina River, upstream of the highway bridge, runs between the highway (east bank) and a bluff on the west bank. Site survey and soils survey determinations were used to predict the flood prone boundary.

## **Lower Tonsina**

The channel is controlled upstream of the bridge on the right bank by a dike or levee; on the left bank there are some levees for protecting properties against high water. Site survey and soils survey information were used to predict flood prone boundary.

# **FLOOD PLAIN MANAGEMENT**

## **General**

The main purpose of this report is not to provide solutions to flood problems in the study area, but to furnish an information base that will encourage flood plain management. The following discusses the general components of a flood plain management program and possible courses of action for the study communities.

## **Establishing a Flood Plain Management Program**

As mentioned, the communities included in this study are ineligible for consideration in the National Flood Insurance Program. The study communities still would benefit from some type of flood plain management program designed to aid the public. The Alaska Department of Community and Regional Affairs, Division of Community Planning, can provide assistance in developing local programs.

A flood plain management program could benefit the public by providing: 1) safe location and minimum floor elevation data for new construction using flood plain management maps from this report, 2) recommendations for land use changes, 3) sponsorship of structure retrofitting and relocation to safe areas, and 4) an impetus for devising a system of disseminating flood warnings. In addition, having a flood plain management program in place can affect decisions made regarding applications for grants or capital improvement projects.

## **Possible Courses of Action**

1. No Action. Present flood potential would remain as is, and future development and land decisions would continue to lack organized guidance.
2. Nonstructural:
  - a. Implement a flood plain management program providing the benefits mentioned above.
  - b. Organize a system for making the information in this report available to the public for individual use.

### 3. Structural:

a. On a case-by-case basis, retrofit structures presently built in flood prone areas (see "Bibliography", Reference No. 1 for detailed information). This can be accomplished by: 1) elevating on a wall, piers, posts or piles to an elevation above estimated high floodwater, 2) constructing levees or flood walls around the structure, 3) treating the structure with sealants to provide waterproofing, and 4) relocating structures to an area outside the estimated flood-prone boundary.

b. With protection of a group of structures as the goal, construct levees (dikes) along watercourses to contain flood flow within the river channel.

## Recommendations

Make the information in this report readily available to the public. The text and maps included herein should be a useful tool for citing new construction and for presenting information and mitigation ideas for landowners in flood-prone areas. Organize a distribution system for flood and erosion information.

As previously mentioned, federally subsidized flood insurance and participation in the National Flood Insurance Program are not an option within the study area. It is still recommended that an organized flood management program be established and a means for active public participation be encouraged.

Communities should request individuals, local historical societies, etc. to compile flood history data from personal interviews and newspaper articles. Records of any new flooding and notable erosion that occurs should be maintained. Important data to compile includes date, nature and severity of flooding, and number of properties affected. Photographs showing high water marks with a measuring rod included provide valuable flood records.

Persons living in flood-prone areas should consolidate into groups when seeking flood prevention or mitigation assistance from state and federal agencies. Keep appropriate legislators informed of flood and erosion concerns. The following lists possible contacts as of the publishing date of this report.

\*U.S.D.A./Soil Conservation Service  
201 E. 9th Avenue, Suite 300  
Anchorage, Ak 99501  
(907) 271-2424

\*Dept. of Army/Corps of Engineers  
P.O. Box 898  
Anchorage, AK 99506  
(907) 753-2753

\*National Weather Service  
AK River Information & Forecast Center  
222 W 7th Avenue  
Anchorage, AK 99501  
(907) 271-3479

\*Dept. of Interior/U.S. Geological Survey  
4230 University Drive  
Anchorage, AK 99508  
(907) 561-5555

\*Alaska Dept. of Community & Regional  
Affairs  
Division of Community Planning  
949 E 36th Avenue  
Anchorage, AK 99508  
(907) 563-1073

\*The Honorable Don Young  
U.S. Congress  
2331 Rayburn, HOB  
Washington, D.C. 20515-0201

\*The Honorable Ted Stevens  
U.S. Senate  
Washington, D.C. 20510-0201

\*The Honorable Frank Murkowski  
U.S. Senate  
Washington, D.C. 20510

## METHOD OF INVESTIGATION AND ANALYSIS

Due to the lack of stream gage and topographic survey data for the areas of this study, empirical hydraulic and hydrologic procedures prescribed by SCS could not be used to determine the extent of the flood plain. Since most flood events of record are related to glacial lake outbursts, ice jams and/or aufeis conditions and since ice events do not follow prescribed probability models, frequency analysis does not provide a reliable prediction of flood boundaries.

Records from four stream gages within the Copper River drainage area were used to develop peak-frequency curves using the Log-Pearson Type III method for frequency analysis. The peak discharge for each area of concern for the 10-, 50-, 100-, and 500-year storm events was obtained from these curves.

### Hydraulics

Stage-discharge relationships were developed for a few valley sections assuming normal flow and using Manning's flow equation. Hydraulic parameters characterizing channel and flood plain conditions up to the mid 1980s were used in the computations. Due to funding constraints, topographic and cross section surveys were not conducted in the selected areas of the study thereby making it necessary to use elevations extrapolated from the USGS quad maps and USGS Discharge Measurement Notes, reducing the accuracy of the projected boundary.

Geomorphic surfaces, soils survey data, high water marks, stream gage records, and other historical flood data were used to determine the actual plotted flood boundary without specific regard to the empirical analysis.

## DATA LIMITATIONS

The flood prone boundaries plotted on the area maps in Appendix A must be regarded as approximate and should be used with caution in connection with any planning of flood plain use. It is difficult to assign a 100- year frequency event to an area like Gulkana, which has less than seven years of flow record. No hydraulic data was

available for the Copper River at Copperville and Silver Springs Subdivision and for the Tonsina River at Lower Tonsina.

Ice and debris jamming, stream channel icing, and glacial outbursts are events which have been taken into account in analysis, but it is impossible to predict and difficult to assign a frequency interval to these events. For instance, the Copper River at the Copperville Subdivision is prone to ice jams but, how often jamming occurs which causes flooding, is subject to many variables. These include the precipitation and temperatures of the basin during the winter season, length and nature of the breakup period, presence of logs and other debris in channel, and other factors.

The boundary shown on the flood plain management maps was approximated using soils and vegetation mapping, geomorphic surfaces, and the historical record. It should be considered a minimum estimate. As the flood boundaries shown are estimates and the actual limits of overflow may vary somewhat from those shown on the maps because the scale of the maps does not permit precise plotting of the flooded area boundaries, it is recommended that a "freeboard allowance" of at least two feet above shown boundaries be provided for any new development or mitigation measure.

Table 1

HYDRAULIC DATA

	<u>Avg. Discharge ac-ft/yr (cfs)</u>	<u>Max. Disch. (cfs)</u>	<u>Max. Stage (ft)</u>	<u>Cause</u>	<u>Date</u>	<u>Period of record</u>
GAKONA RIVER at Gakona	627,400 (866)	10,300 UNK	7.92 8.54	Storm Event** Ice Jam	8/56 3/65	1948-74
GULKANA RIVER at Sourdough*	770,100 (1,063)	9,170	--	Snowmelt**	6/77	1972-78, 1982
Copper River at Copperville	HYDRAULIC DATA UNAVAILABLE					
TAZLINA RIVER at Tazlina	2,960,000 (4,085)	60,700	13.19	Glacial Outburst	8/62	1949-50, 1951-72
COPPER RIVER at Silver Springs	HYDRAULIC DATA UNAVAILABLE					
KLUTINA RIVER at Copper Center	1,221,000 (1,686)	9,040 UNK	9.24 15.55	Glacial Outburst Ice Jam	6/53 5/53	1949-67, 1970
TONSINA RIVER at Tonsina	611,500 (844)	8,490 UNK	4.91 7.00	Snowmelt** Snowmelt**	6/62 6/57	1950-82
TONSINA RIVER at Lower Tonsina	HYDRAULIC DATA UNAVAILABLE					

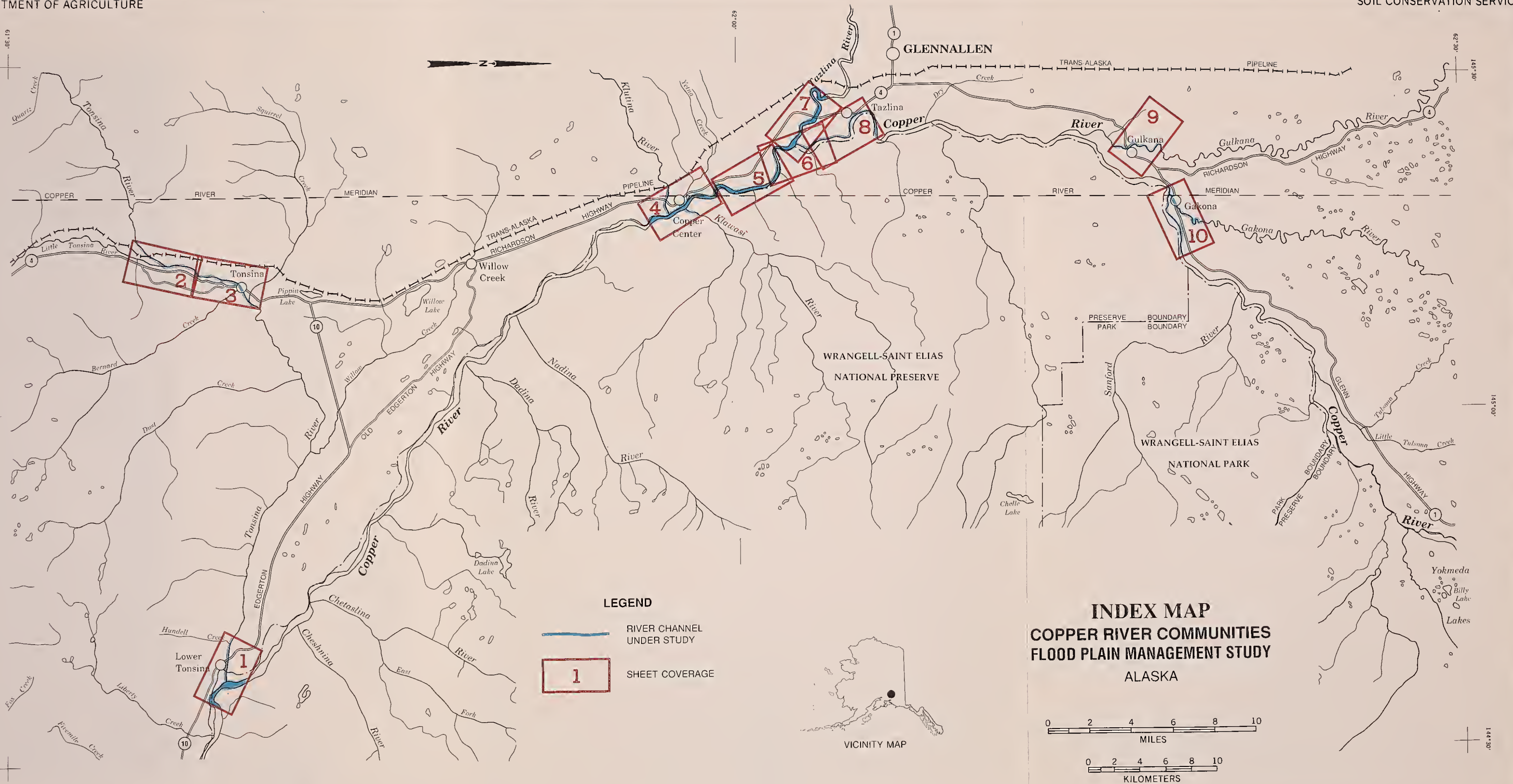
\* Sourdough is approximately 20 miles upstream of Gulkana; maximum discharge can be applied to the Gulkana River at Gulkana.  
\*\* Cause of maximum discharge unlisted in historic records; shown is author's estimate



# APPENDIX A

Flood Plain Management Map Index  
Flood Plain Management Maps







LIMIT OF STUDY



EDGERTON

HIGHWAY

10

LOWER  
TONSINA

TONSINA

RIVER

LIMIT OF STUDY

LIMIT OF STUDY

LEGEND

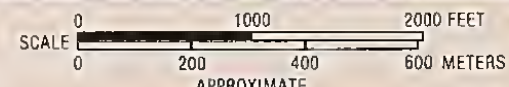


Approximate  
Flood Hazard Area



Flow Arrow

NOTE:  
LIMITS OF FLOODING SHOWN MAY VARY  
FROM ACTUAL LOCATIONS ON THE GROUND  
AND DUE TO INHERENT AERIAL PHOTOGRAPHIC  
DISPLACEMENT THE PHOTOGRAPHIC IMAGE  
MAY VARY FROM TRUE GROUND LOCATION.



1" = 1000' Color Aerial Photography  
and 1" = 1 Mile CIR Photography



U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE  
COPPER RIVER COMMUNITIES  
FLOOD PLAIN MANAGEMENT STUDY AREA  
ALASKA

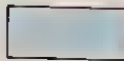
FLOOD HAZARD AREA

LOWER TONSINA





LEGEND



Approximate  
Flood Hazard Area



Flow Arrow

NOTE:  
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DISPLACEMENT THE PHOTOGRAPHIC IMAGE  
MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 1000 2000 FEET  
0 200 400 600 METERS  
APPROXIMATE

1" = 1000' Color Aerial Photography  
and 1" = 1 Mile CIR Photography



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ALASKA

**FLOOD HAZARD AREA**

**TONSINA**



USDA SOCS 601046 0401040404040404 11 100114 14 1991



Approximate Flood Hazard Area

Flow Arrow

NOTE  
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

010002000

FEET

0200400600

METERS

APPROXIMATE

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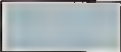
FLOOD HAZARD AREA

TONSINA

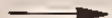


USDA NATIONAL CARTOGRAPHIC CENTER, JT 1004262, 1991



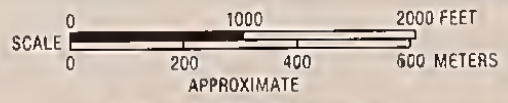


Approximate  
Flood Hazard Area



Flow Arrow

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ALASKA

# FLOOD HAZARD AREA

## COPPER CENTER





USDA NATIONAL CARTOGRAPHIC CENTER, 37 NORTH 34 EAST

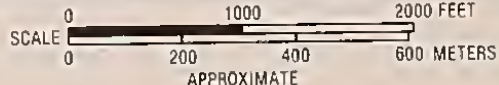


**LEGEND**  
Approximate  
Flood Hazard Area



Flow Arrow

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AUGUST 1991 1004262

SHEET 5 OF 10

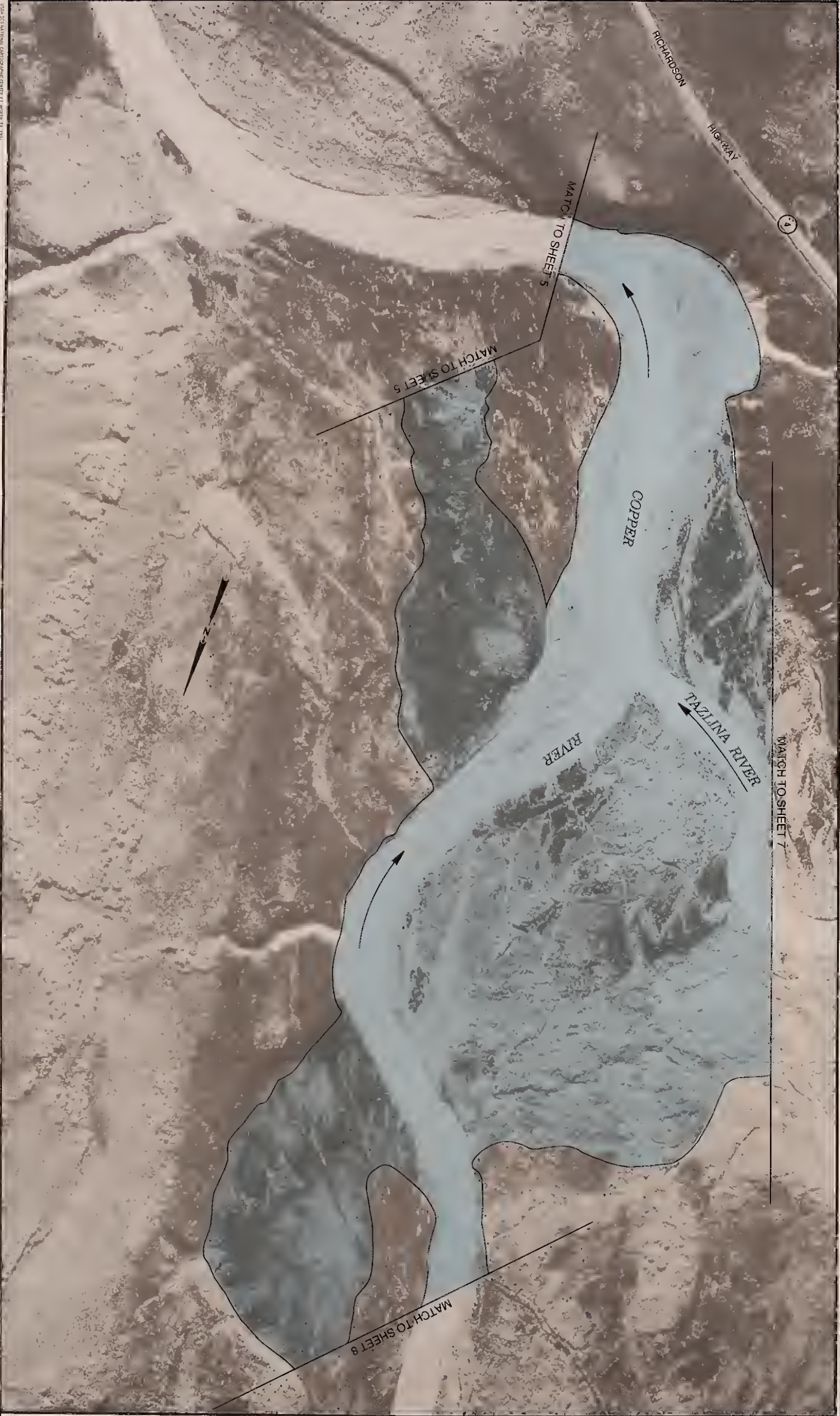


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ALASKA**


**FLOOD HAZARD AREA**

**SILVER SPRINGS**






**LEGEND**



Approximate Flood Hazard Area



Flow Arrow

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DISPLACEMENT THE PHOTOGRAPHIC IMAGE  
MAY VARY FROM TRUE GROUND LOCATION

**SCALE**

010002000 FEET

0200400600 METERS

APPROXIMATE

1" = 1000' Color Aerial Photography  
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SHEET 6 OF 10

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ALASKA

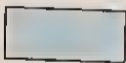
**FLOOD HAZARD AREA**

**TAZLINA AND COPPERVILLE**





**LEGEND**

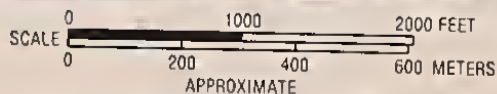


Approximate  
Flood Hazard Area



Flow Arrow

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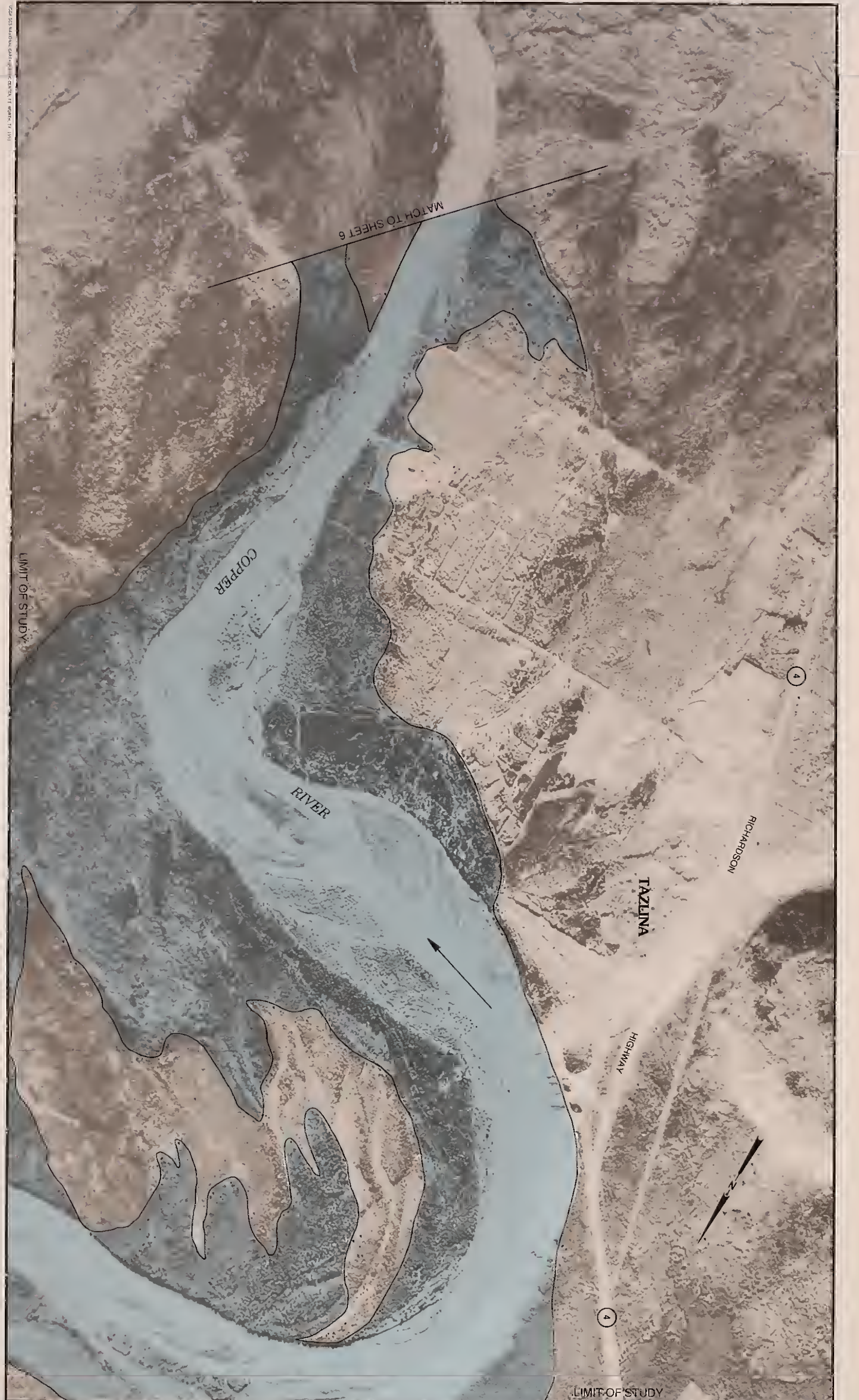


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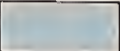
U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE  
COPPER RIVER COMMUNITIES  
FLOOD PLAIN MANAGEMENT STUDY AREA  
ALASKA

**FLOOD HAZARD AREA**  
**TAZLINA AND COPPERVILLE**

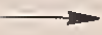




**LEGEND**



Approximate Flood Hazard Area



Flow Arrow

**NOTE:**  
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**SCALE**

010002000 FEET

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APPROXIMATE

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**FLOOD HAZARD AREA**

**TAZLINA AND COPPERVILLE**

U.S. SOIL CONSERVATION SERVICE, CENTER FOR NORTH, 14 1993

AUGUST 1993 1004262





# LEGEND



Approximate  
Flood Hazard Area



Flow Arrow

NOTE:  
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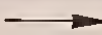
LIMIT OF STUDY

LIMIT OF STUDY

LEGEND

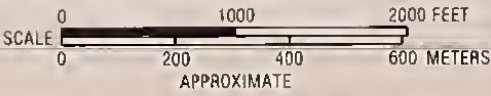


Approximate  
Flood Hazard Area



Flow Arrow

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FLOOD HAZARD AREA

GAKONA





# APPENDIX B

Natural Values of Flood Plains  
Environmental Assessment



# NATURAL VALUES OF FLOOD PLAINS

In riverine flood plains, processes shaping life on land and in water overlap. A unique combination of conditions result. Riverine flood plains tend to be characterized by fertile soils, productive and diverse plant and animal communities, microclimates more stable and mild than those of surrounding uplands, level to gently undulating topography, and plentiful water supplies. Undeveloped flood plains reduce flood severity and protect water quality and quantity by providing areas where flood flows spread out, slow down and infiltrate. Because moving waters create flood plains, waterborne nutrients, sediments, and living organisms are deposited on flood plains from distant sources. In addition, flood plains and the rivers they border form linear travel corridors used by fish, wildlife, and humans moving among environments within a watershed. General flood plain values are discussed in detail in a variety of reports. The following discussion focuses on natural values that could be provided by lands and flood plains associated with the rivers of the study area.

As mentioned above, flood plains potentially provide many natural values to local communities, particularly if their hazards as building sites are recognized and adapted to and managed for their natural benefits. A comparatively rich variety of wildlife species use habitats close to rivers ("riparian" habitats). Although some species may avoid or be unable to survive in or close to urban lands in the study area, overall the variety of wildlife species in habitats along the rivers will be higher than in comparable habitats away from water. An obvious reason for this is that many kinds of food and shelter can be found near water. As a result, in addition to supporting animals typically found in similar upland habitats, riparian habitats also support: (a) animals that feed mostly in water while nesting or denning in trees, banks or burrows (e.g., river otters, minks, kingfishers, bald eagles, dippers, and waterfowl), b) species that feed largely on land plants but use water for cover (e.g., beavers and some waterfowl), and c) species that feed both in water and on land (e.g., moose, bears, weasels, muskrats, and waterfowl). Lands along rivers are important and often critical in maintaining populations of riparian birds and mammals.

Along with flowing water, "structural diversity" of riparian plant communities increases the kinds of food and shelter available in many riverside habitats. Structural diversity is created when plants of many

shapes and sizes, particularly trees and shrubs of different heights, grow on the same plot of land. Such varied plant layers can develop where sunlight reaches all levels of vegetation from the ground up. Along waterways, sunlight can often penetrate into bordering forests and promote well-developed shrub and herbaceous understories. The result is the multilayered pattern of plants common along many streams. Each plant layer provides food, cover and space to different species of wildlife. Thrushes and warblers occupy tree canopies; juncos and sparrows occur near the ground; woodpeckers use tree boles; red and flying squirrels nest and feed among tree branches; marten are active both on the ground and in the trees; mink, fox and hare feed and hide among shrubs; and other species occur where appropriate conditions are found.

The variety of habitats along rivers and streams is also increased by the high "interspersion" typical of riparian areas. Interspersion is created when many different kinds of habitats or plant communities occur in a patchwork pattern, for example, where forest stands, grasslands, shrub lands and open water occur within a relatively small area. Interspersion, like structural diversity, increases the kinds of habitats present, thus providing more kinds of food and places to shelter and reproduce for more kinds of wildlife.

Forest species such as squirrels, woodpeckers, black bear, marten, and spruce grouse can be accommodated close to shrub-land species such as snowshoe hare and grassland species such as voles and sparrows. In addition, many animals such as fox, coyote, bear, raven, moose, birds of prey, etc., prefer areas of high interspersion because they provide diverse kinds of plant and animal food, as well as opportunities to feed in one kind of habitat while sheltering in another. Many "edge" species of wildlife are not found where homogeneous plant communities cover large unbroken expanses.

Rivers and streams tend to continually renew the variety and structural diversity of plant communities found on bordering lands. Flooding, shifts of channel, abandoned oxbows, deposition of sand or gravel bars etc., create new clearings, modify existing terrain, and initiate new stages of plant succession all of which promote variety in and among habitats present.

Flood plains and riparian plant communities also serve important functions in enhancing aquatic habitats in adjacent waterways. Instream habitats are used by aquatic invertebrates, fish (which often

feed on invertebrates), and a variety of birds and mammals that feed on fish, invertebrates or aquatic plants. Maintaining or enhancing instream habitats depends, to a large extent, on maintaining appropriate vegetation along waterways; reducing streamside vegetation tends to lower the quality of related aquatic habitats.

Riparian vegetation enhances instream habitats in a number of ways. Water quality, for example, can be degraded if too many sediments, chemicals or organic pollutants are carried to streams by runoff from areas upslope. Riparian vegetation (and watershed vegetation in general) reduces these inputs by slowing overland runoff. As runoff is slowed, waterborne sediments and other solids settle out and surface flows can infiltrate soils. As a result, less material is carried into waterways. The same processes occur when overbank (flood) flows move through flood plain vegetation. As they do, water velocities decline, sediments are deposited (which enrich flood plain soils), and erosion is reduced.

For the same reasons, riparian (and upland) vegetation reduces soil erosion and bank gully and slumping. Well-vegetated streambanks slow both surface runoff and flood flows. Slower flows have reduced capacities to pick up and carry sediments so they are less likely to erode, gully, or undercut streamside lands. The greater the "roughness" of the vegetation through which surface or flood waters flow, the more effectively velocities are slowed and erosion is reduced.

Even poorly vegetated flood plains help reduce the severity of overbank flooding. By providing broad areas over which flood waters spread, flood plains increase area wetted and decrease water depth, both of which reduce water velocities and decrease downstream flooding. Depressions in flood plain terrain, such as abandoned channels, oxbow lakes, potholes, and wetlands, help to trap, retard and "soak up" floodwaters, reducing their velocity and depth. Slowing down flows also helps whatever vegetation is present to withstand flooding. Entrapment of water in depressions provides refuges where organisms are sheltered from strong currents.

Riparian vegetation also benefits instream habitats by contributing organic litter (such as leaf fall) to aquatic food chains and by providing sources of large organic debris such as fallen trees. Large organic debris falling into streams creates aquatic

"microhabitats". Aquatic invertebrates, fish, birds and mammals can find shelter among fallen stems and branches, as well as sites with reduced flow velocities. Many species, particularly fish and invertebrates, use such microsites for resting, feeding or laying eggs. Too much debris, however, can choke streams and block passage of aquatic animals.

Streamside vegetation also moderates and stabilizes water temperatures and riparian microclimates. Such vegetation filters sunlight, reduces radiation and convective heat loss from water and land surfaces, and reduces local wind speeds. As a result, fish and wildlife using streams or riparian lands with dense vegetation often find comparatively mild and stable microclimates.

Groundwater recharge is also enhanced where surface and overbank flows are slowed by vegetation or topographic depressions. When filled by flood flows, depressions found in flood plains permit surface waters to percolate down to groundwater reservoirs (aquifers) and replenish them.

During dry seasons, underground water moves from aquifers into streams and lakes whose water levels have dropped below the water table. Such groundwater outflow may be the primary source of water in some lakes and streams during low-flow periods. Many aquifers providing important sources of water to human settlements are recharged primarily from nearby flood plains.

Lands along rivers have traditionally provided sites for a variety of human activities. Since prehistoric times, human cultures have focused their energies and settlements along waterways (despite the frequent flooding of settlements) because these areas tended to concentrate and funnel fish and wildlife and provided relatively easy travel routes -- with boats in summer, sleds (and now also snowmachines and 4-wheelers) in winter. The popularity of fishing, trapping, hunting, rafting, kayaking, canoeing, dog mushing, hiking, camping, and wildlife viewing on rivers or adjacent lands continues to grow. Riparian lands can readily be enhanced to promote fish, wildlife, recreation, and aesthetics. If so managed, they can become tremendously valuable to local communities in terms of the resources and outdoor recreation they provide. Lands along the study area rivers have high potential for providing most of these natural values.

# ENVIRONMENTAL ASSESSMENT

## General

Though no specific flood control measures are addressed in this study, any steps that are taken to control the channels or remediate damage must consider environmental impacts. The following are general recommendations for minimizing negative environmental effects to fish and wildlife.

- Minimize construction of roads.
- Minimize disturbances to streambanks, riparian vegetation and to mature plant communities; in particular, avoid cutting mature trees and damaging existing streambank vegetation.
- Create wildlife cover such as brush piles.

- When moving equipment and material into the river channel, limit access points into and out of the river and if possible, select locations where mature vegetation (particularly trees) will not be disturbed and have access points approved by Alaska Dept. of Fish and Game.

- Minimize duration of construction activities and schedule construction activities to minimize disturbances to breeding wildlife and migrating fish.

- Consult with the appropriate regulatory agencies (Corps of Engineers or Alaska Dept. of Fish and Game) prior to project design or construction for permits and to ensure that fish and wildlife impacts are adequately identified and addressed.



# APPENDIX C

Report Authors and Credentials



## REPORT AUTHORS AND CREDENTIALS

Name	Present Title and Years	Education	Previous Exp. Title & Yrs.	Other
JONES, Keith R.	Hydraulic Engr.-2 yrs	BS-CE	CE - 2 yrs Environ Engr - 1 yr	EIT Cert.
KAISER, Joanne	Hydraulic Engr.-1 yr	BS-CE	CE - 3 yrs	EIT Cert.
LOUTHAN, James D.	State Engr. 5 yrs	BS-AgE	CE - 7 yrs Area Engr. 3 yrs AgE - 6 yrs	PE (AK) Member - ASAE



# GLOSSARY

**Anadromous stream** - Used by fish from the sea for breeding

**Aufeis** - A German word meaning "upon ice", this is the formation of ice in a river channel. Occurs when water from a constant, unblocked source (such as a spring) continually flows over previously formed ice and freezes. Aufeis is most likely to occur where channel slope flattens causing flow velocity to decrease thereby lessening the cutting power of water.

**Break up** - A period in the spring when the winter's snow and ice accumulations melt and runoff occurs.

**Channel** - A natural or man-made open conduit that periodically or continuously conveys water. River, creek, stream, branch and tributary are terms used to describe natural channels.

**Discharge** - Rate of flow at a given instant in terms of volume per unit of time, e.g. cubic feet per second (cfs).

**Drainage area** - The land area, measured in a horizontal plane, which contributes flow to a body of water at a certain location. See watershed.

**Erosion** - Detachment and movement of soils or rock fragments by water, wind, ice or gravity.

**Flood** - Overflow or inundation of normally dry lands from a stream or other body of water, measured by either stage or discharge.

**Flood frequency** - The predicted average interval of time between floods generally expressed in years. Following are examples:

10-year flood or 10-year frequency flood. Measured by stage or discharge, the flood which will be matched or exceeded on an average once in 10 years, and which would have 10 percent chance of being equaled or exceeded in any given year.

50-year flood ... two percent chance ... in any given year.

100-year flood ... one percent chance ... in any given year.

500-year flood ... two-tenths percent chance ... in any given year.

**Flood hazard** - A general term meaning the risk to life or damage to property from: overflow of river or stream channels, extraordinary waves or tides occurring on lake or estuary shores, flood flow in intermittent or normally dry streams, floods on tributary streams, floods caused by accumulated debris or ice in rivers, or other similar events.

**Flood plain or flood prone area** - Land area that is subject to flooding which lies adjacent to a channel or body of water.

**Flood plain management** - The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works and land use and control measures.

**Freeze up** - Occurs in the fall when continual subfreezing temperatures result in ground which stays frozen until spring break up.

**Gabion** - A wire basket filled with small to medium size rock (often excavated river bed cobbles) and connected to other similar baskets. Used for flood and erosion control.

**Glaciofluvial detritur** - Material produced by the disintegration and weathering of rock that has been moved from its site of origin by streams flowing from glaciers.

**Greenbelt area** - A strip of land kept in a natural or relatively undeveloped state, or in agricultural use, established around urban developments or along the flood plain of a stream or body of water.

**Headwater** - The source of a stream or the water upstream from a structure or point on a stream.

**Loess** - A homogeneous, nonstratified deposit consisting mainly of silt with some small amounts of very fine sand and/or clay.

**Permafrost** - Perennially frozen ground.

**Riprap** - Large angular rock placed on an earthen embankment or in a drainage channel for erosion control.

**Runoff** - The portion of precipitation or snowmelt which is discharged from a drainage area. Types include surface runoff, ground water runoff and seepage.

**Sediment** - Mineral and organic material transported by air, water, gravity or ice.

**Stage** - Elevation of a water surface above a chosen datum plane (often an established low water plane).

**Stream** - Any natural channel or depression through which water flows continuously, seasonally or intermittently.

**Structure** - Something constructed by mankind that requires a more or less permanent location on or in the ground, including but not limited to bridges, buildings, canals, dams, ditches, diversions, irrigation systems, pumps, pipelines, railroads, roads, sewage disposal systems, underground conduits, water supply systems, boat docks and wells.

**Watershed** - A land area comprised of one or more drainage areas and characterized by certain plant and animal habitats.

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